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ABSTRACT

This manual is designed to assist regulatory pest control applicators to meet the requirements of the Michigan Department of Agriculture for certification. The guide discusses: (1) Factors influencing introduction and spread of pests and their population dynamics; (2) Methods and techniques used to suppress, control, or eradicate pests of regulatory significance; (3) Examples of regulated pests; (4) Safe use of pesticides in regulatory programs; and (5) Emergency procedures and special application equipment. A list of self-help questions and instructions for completing the questions are presented at the end of each section. (HM)

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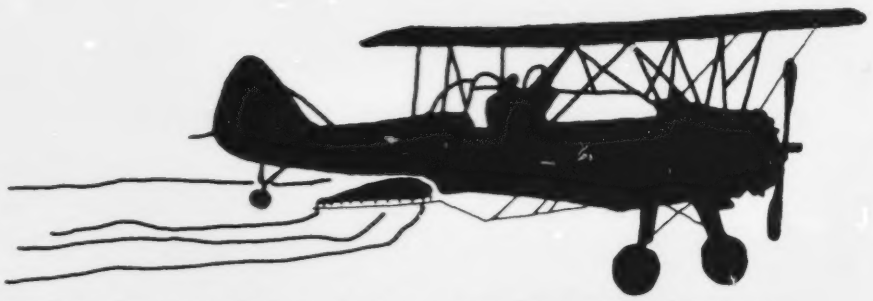

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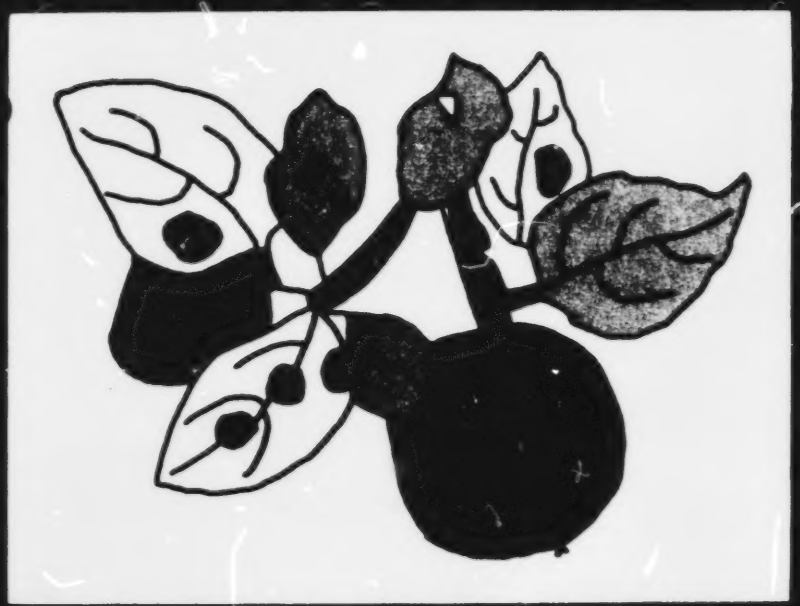
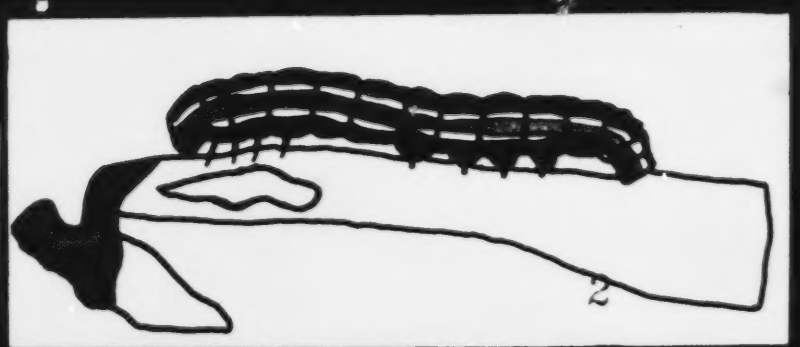
A MANUAL FOR COMMERCIAL APPLICATORS





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This manual is intended to assist regulatory officials prepare for certification under the Michigan Pesticide Control Act of 1976. The manual was prepared by Mr. Robert Mesecher of the Plant Industry Division, Michigan Department of Agriculture.

A list of self-help questions and instructions for completing the questions are at the end of each section. If you encounter difficulties in using the manual, please consult your county agricultural extension agent or representative of the Michigan Department of Agriculture for assistance.

Some suggestions on studying the manual are:

1. Find a place and time for study where you will not be disturbed.
2. Read the entire manual through once to understand the scope and form of presentation of the material.
3. Then study one section of the manual at a time. You may want to underline important points in the manual or take written notes as you study the section.
4. Answer, in writing, the self-help questions at the end of each section. Instructions on how to use the self-help questions in your study are included with the questions. These questions are intended to aid you in your study and to help you evaluate your knowledge of the subject. As such, they are an important part of your study.
5. Reread the entire manual once again when you have finished studying all of its nine sections. Review with care any sections that you feel you do not fully understand.

This manual is intended to help you use pesticides effectively and safely when they are needed. We hope that you will review it occasionally to keep the material fresh in your mind.

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REGULATORY PEST CONTROL

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PREFACE

The objective of regulatory pest control is to prevent the introduction and/or spread of pests and diseases through the application of suppression, control, and eradication pest control methods. The objective is achieved through limiting movement of commodities and materials and the treatment of commodities, materials and the environment for the purpose of preventing the establishment of pests and diseases where they have not been previously established. An organism can become a regulated pest when for example, it inferferes with health, comfort, leisure, aesthetic satisfaction, recreation, stability of existing biological systems, and agricultural and material production. Organisms which may be considered pests include insects, fungi, weeds and other organisms as defined in the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended.

Regulatory pest control measures include, but are not limited to, the following fundamental prerequisites: (1) the pest offers an actual and expected threat; (2) no substitute action, less disruptive of normal trade, is available; (3) the objective must be reasonably attainable; and (4) the economic gains outweigh the costs of application of control measures. Practices of regulatory pest control are changing constantly through technological advances and through changes in legislation.

INTRODUCTION

Federal pesticide regulations set general and specific standards for regulatory pest control applicators that you must meet before you can apply restricted use pesticides. This guide contains the basic information to assist you in meeting the specific standards of category 9, regulatory pest control. It contains the information you need to know to meet the minimum specific standards by Federal regulations for certification.

This guide will discuss:

- factors influencing introduction and spread of pests and their population dynamics;
- methods and techniques used to suppress, control, or eradicate pests of regulatory significance;
- examples of regulated pests;
- safe use of pesticides in regulatory programs;
- emergency procedures and special application equipment.

The information needed to meet the general pesticide applicator standards is included in the guide "Apply Pesticides Correctly - A Guide For Commercial Applicators".

CHAPTER I

STATUTORY AUTHORITIES FOR THE PROTECTION OF PLANTS, ANIMALS AND PLANT AND ANIMAL PRODUCTS

One of the principal reasons for the spread of pests and diseases shipped throughout the world is inadequate control of such pests in the country of origin. Regulations cannot prevent, though they may hinder or delay, the spread of pests to new territories. Adequate control of pests in countries of origin is the best safeguard against their spread to other countries, including the United States. Although this principle is widely accepted, the practical application is very slow. In the meantime, we must continue to depend on laws and regulations to protect against outside pests and to control pests within our borders.

The existence and responsibilities of Federal regulatory programs are provided for by congressional acts and by delegations made by the Secretary of Agriculture. The acts provide the Secretary of Agriculture with authority to: (1) establish restrictive and prohibitory quarantines and regulations against imports likely to be the means of introducing pests not known to be present or widely distributed in the United States; (2) establish quarantines and regulations to carry out cooperative Federal-State-Mexican suppression, control, or eradication measures against designated pests which become established in the United States or Mexico; and (3) provide export certification of domesitc products when requested by interested shippers and parties.

The acts, and regulations based on them, provide the foundation for a flexible but effective program for protecting the country against foreign pests. Under the acts, the USDA has broad authority to take appropriate measures against threatening pests and to promulgate or modify existing regulations whenever necessary.

Most states have similar pest regulatory authority, but due to wide variation among the states, local plant and animal regulatory officials should be contacted.

A. Federal/State Quarantine Regulations

A listing of all plant and animal pests presently under Federal/State quarantine regulations would be of little use to persons using this manual. More than 1,300 species of foreign insects and diseases are considered to be a significant threat to U. S. agricultural resources.

Also included under Federal/State quarantine regulations are the various plant and animal pests already established in certain sections of the U. S. Although this list of pests is much smaller, it would be of little value to discuss each species. Anyone wishing detailed information about the regulated pests, lifecycles, distribution, methods of control and other pertinent information is referred to the Animal and Plant Health Inspection Service (APHIS) manuals. This information is available to regulatory personnel in any of the APHIS area offices or in the regulatory offices of cooperating states. Listed below are several examples of the animal and plant pests presently under federal regulation. The selection of these particular species is merely based upon the diversities in methods of control, modes of attack, and differences in speciation.

Golden Nematode

The golden nematode is one of the world's most damaging pests of potatoes. It also damages tomatoes and eggplants. This cyst forming nematode bores into the roots of potatoes and feeds on their juices. Because nematodes do not cause immediate damage to the aboveground part of an infested plant, they often go undetected for years.

A serious pest in Europe, the nematode was first found in the United States in a potato field on Long Island, New York. USDA and New York are currently dealing with a small, isolated infestation in the northwestern portion of the state and a few infested fields on Long Island. Although contained in these areas by the State/Federal program of plant pest control, the nematode remains a threat to this country's potato industry. Plant pest control workers inspect soil samples collected from potato fields and potato-grading stations. Surveys are conducted to detect new areas of infestation and to determine the limits of known infestations. Soil fumigation, the use of nematocides, and the development of nematode-resistant potatoes are the ways that the golden nematode is being controlled.

Boll Weevil

The boll weevil is one of the world's most destructive insect pests and the major pest of cotton. Estimated losses in cotton, plus cost of the control work, are figured in the hundreds of millions of dollars annually.

Native to Mexico or Central America, this insect invaded the United States near Brownsville, Texas. It spread over cotton-producing areas stretching from the Atlantic seaboard to the Texas High Plains. Any new westward spread would threaten valuable cotton-producing areas in west Texas, Arizona, New Mexico, and California.

The adult boll weevil hibernates during the winter in many kinds of protected places. The adults emerge from hibernation during the spring and early summer. The female weevil deposits eggs in squares or bolls. The development from egg to adults takes place within the square or boll. Under ideal conditions, five to six generations a year are produced in the major cotton-producing areas of the United States that are infested with boll weevil.

Witchweed

Witchweed is a parasitic plant that attacks the roots of corn, sorghum, sugarcane, and several other members of the grass and sedge family. This pest was first discovered in the United States in adjoining areas of North and South Carolina in 1956. It has been confined to those two states ever since by the cooperative Federal/State control program. If it became widespread, it is estimated it could cause isolated losses of up to 85% in infested crops.

Witchweed robs the host plants of nutrients and water, slowing the growth of the plant and causing acute symptoms of drought, even in the presence of sufficient moisture. Corn that is stunted and wilted and fails to recover following adequate rainfall may be affected by the parasite. Heavy infestation may cause the death of many host plants and yield will be seriously affected.

Federal and State quarantines are enforced to prevent the movement of articles that might spread the pest. Applications of herbicides are made each season to keep witchweed growth suppressed. Biometric surveys are conducted in noninfested areas to detect any new infestations.

The newest control technique involves injecting ethylene gas below the soil surface. The gas triggers germination of witchweed seeds. The witchweed plants are either treated with a herbicide or die from lack of a host.

Gypsy Moth

The gypsy moth is a pest of forest and ornamental trees. Damage is caused by the caterpillars, or larvae, feeding on leaves. Repeated defoliations can kill hardwood trees; some softwoods cannot survive a single defoliation. Weakened trees are subject to secondary attack by diseases and other insects.

In 1869, specimens were imported from France for experimental purposes and escaped from a laboratory at Medford, Massachusetts. For many years, Federal/State quarantine and control activities kept the moths confined to New England, New York and Pennsylvania.

Recently gypsy moth has spread rapidly and is now established throughout much of the Northeast. Small, isolated outbreaks have been found in several states outside the Northeast. Recreational vehicles and mobile homes are an important channel for long-distance spread.

The present cooperative program consists mainly of (1) enforcing Federal/State quarantines, (2) control work at infested campgrounds and mobile home parks to minimize artificial spread, (3) nationwide surveys to spot spread promptly into uninfested areas, and (4) biological controls.

The gypsy moth develops in four stages: egg, larva (caterpillar), pupa (transformation stage), and adult (moth). Only the larval stage is destructive. In the presently infested states, caterpillars begin to enter the pupal stage in late June, and after a period of 10 to 14 days, adults emerge. After mating, the female deposits eggs on trees, stones, buildings and shaded objects. The eggs begin to hatch next spring in late April and the process continues for a period of two weeks. The caterpillars feed from late April to early July.

Screwworms

Screwworms are the larvae, or maggots, of the screwworm fly. They are a serious pest of warm-blooded animals--livestock, pets, wildlife, and even humans. They closely resemble common blowfly maggots. But unlike blowfly maggots--which feed on carrion or dead or diseased tissue-- screwworms consume the healthy flesh of the warm-blooded animals they infest.

Screwworms are found in open untreated wounds. The female fly lays a mass of eggs on the edge of a wound. Larvae hatch from these eggs and burrow into the flesh, where they feed. Mature larvae drop to the ground and pass through their pupal stage in the soil. Later, usually in about 10 days but sometimes as much as 60 days depending on the weather, they emerge from the soil as flies. Within days the flies mate, and begin infesting livestock with a new generation of screwworms.

Screwworms seriously injure, maim, or kill infested animals, particularly if wounds are untreated and become reinfested. Screwworm larvae feed continuously. They grow from nearly microscopic size to about one-half inch in length, and in the process greatly enlarge the wound. This destructive parasite was a major pest throughout the southern and southwestern states, and today is still found in Mexico, Central and South America and the Greater Antilles Islands.

The destruction caused by screwworms has been greatly reduced in the United States and in parts of Mexico, in comparison with what it was before the cooperative eradication program was initiated using a unique technique.

The sterile male eradication technique was first used successfully in a pilot project on the Carribean island of Curacao. It then was successfully applied in the southeastern and southwestern United States, and in the Virgin Islands. The continuous release of sterile flies throughout the Unites States-Mexico border area creates a barrier zone against migrating screwworm flies that might reinfest the United States.

Now, the United States and Mexico are extending screwworm eradication efforts southward in Mexico. There, a new and more effective barrier zone will be established and maintained--by continuous sterile fly release--to protect the North American continent against future screwworm migrations.

Cattle Scabies

Scabies is a contagious skin disease of cattle. The disease is produced when tiny parasitic mites pierce the animal's skin to feed. Discharge from the mite wound oozes onto the surface of the skin and forms scabs or crusts. At times, the affected areas also become infected with bacteria.

Cattle with scabies lick, rub, and scratch themselves to relieve intense itching. They lose weight and condition. Occasionally, animals die from heavy infestations by scabies mites.

Cattle scabies can be eradicated by treating affected and exposed cattle with chemicals that kill the mites. Cooperative Federal/State eradication programs using such treatments have eliminated cattle scabies from large sections of the United States. The United States Department of Agriculture and the states now are cooperating to complete the eradication of psoriatic cattle scabies.

All cattle are susceptible to all kinds of scabies. Cattle may be infested with more than one species of scabies mites at one time. Most mites causing cattle scabies can be eradicated by the same treatment. Most scabies mites are similar in appearance--adults are eight-legged, oval-shaped, whitish parasites. All are barely visible to the unaided eye. The mites are more easily found if scrapings from an affected animal's skin are placed on a dark background and magnified under a hand lens.

Mites spend their lives in and on the skin of the host animal. They require 10 to 12 days to complete their life cycles. Off the host, mites generally survive only a few days.

Direct contact is the most common means of spreading scabies from one animal to another. Scabies-causing mites are also transmitted by infested equipment. Often they are unintentionally spread when affected animals are sold or exchanged.

Ordinarily, scabies does not spread from one species of animal to another species. For example, cattle scabies does not spread to sheep.

Dairymen and other persons working closely with livestock may get scabies. The mites may cause great discomfort. Consult a physician for treatment.

Because of scabies, states control the movement of cattle within their borders. Federal laws prohibit the interstate shipping, driving, or moving of cattle that have scabies. Interstate movement is permitted, however, after infected or exposed cattle have been freed of mites by proper treatment and if the cattle have been properly certified.

Your local veterinarian, your state veterinarian, or the Federal veterinarian in charge can give you further information about current eradication programs.

Cattle Fever Ticks

Cattle fever ticks may spread a severe and often fatal disease of cattle which is known as cattle tick fever, southern cattle fever, red water, splenic fever and Texas fever.

Even if infested cattle do not get tick fever, cattle fever ticks produce general unthriftiness and may spread other cattle diseases.

Cattle tick fever has caused enormous losses in the past. Before a nationwide eradication program began, the disease took a heavy toll in American cattle each year. If the disease had not been eradicated from the United States, the cattle industry's losses from ticks probably would amount to $1 billion annually.

Cattle fever ticks infest most tropical and subtropical areas of the Western Hemisphere. They frequently are found in the part of Texas that borders on infested parts of Mexico, and occasionally are found in California.

Cattle fever ticks spend the early part of their lives on the ground. Then they infest cattle, or occasionally horses, mules, sheeps, goats, or deer. The ticks must have blood from an animal host to complete their life cycles.

Moisture and temperature affect the cattle fever tick's development. In spring, summer, and early fall, a tick may complete its life cycle in 6 to 10 weeks. If growth is delayed by cold, a tick may take a year to complete its life cycle.

The female cattle fever tick dies after laying a cluster of eggs on the ground.

The newly hatched seed ticks, or larvae, are barely visible to the unaided eye. These six-legged ticks crawl up grass or plants, where they wait for an animal to pass by. If ticks do not find a host, they eventually die of starvation.

Usually these ticks attach themselves where they suck blood, or engorge, molt, and develop into eight-legged nymphs.

After engorging about a week, nymphs become adults. Mature ticks mate without leaving the host animal. Then the female drops to the ground, where she deposits her eggs. Cooperative Federal/State programs provide quarantines, inspections and treatment.

Infested and exposed cattle are dipped in pesticides that kill ticks. Although a single treatment should kill the ticks on an animal, it will not assure eradication because it does not prevent reinfestation. Only long-range programs can rid an area of ticks. For this reason, cattle are dipped at regular intervals for at least one year.

Prevention--keeping ticks out of the United States--is a major part of the program against cattle fever ticks. A quarantine zone is maintained on the U. S. side of the lower Rio Grande River. Cattle from Mexico are carefully inspected for cattle fever ticks at the border. They must be free of these ticks and must be given a precautionary dipping before they can be imported.

Without these controls, cattle fever ticks would reinfest areas of the United States that have warm climates.

Post Entry Quarantine

Plant viruses are sometimes difficult to detect due to their latent nature.

Certain plant species are susceptible to virus diseases that can be spread from one plant to another and cause serious reduction in yields of important agricultural crops. Virus diseases are impossible to detect during the dormant stage of the plant and can only be detected during the time a plant is actively growing. Also, the virus may be latent in nature and more than one growing season is necessary to detect its presence. As a safeguard against this type of plant disease, a permit must be obtained from the USDA, Animal and Plant Health Inspection Service (APHIS), to import plants from a foreign country. Inspectors at the point of entry notify the destined state officials of arrival whereupon the imported plants are inspected at the destination site. If the inspection discloses certain of the plant species susceptible to virus diseases, the plants are caused to be isolated and grown under post entry quarantine for a minimum of two years. The time period for post entry quarantine will vary depending upon the particular state's requirement. Absolute control over the plants is maintained until released by an authorized inspector at the end of the quarantine period.

B. Michigan Quarantine Regulations

The State of Michigan has legislation to prevent importation of all serious pests and contagious plant diseases and provide for their repression and control. The legislation provides authority for the commission of agriculture to establish such quarantines as it shall deem necessary for the proper enforcement of the act. Listed below are examples of pests presently under state regulation.

Geranium Plume Moth

Geranium plume moth (Platyplilia pica) has caused serious crop losses at several Michigan greenhouses in recent years. This pest is not native to Michigan, but has been found infesting geranium cuttings brought from California where several generations occur each season. Geranium stock that appears in good condition at the time it is shipped may be infested with the egg stage attached to the leaves. After the cuttings arrive, the eggs hatch and plume moth caterpillars bore into stems and buds causing extensive damage. Refuse from the borings can be noted at the tunnel entrance made by the caterpillar but plants are already injured and take on a yellowish, unhealthy appearance before this is noticed.

Full grown caterpillars are 1/4 to 3/8 inches long and either reddish or green. Pupal cases are attached to the stems or sometimes protruding from exit holes in buds. The adult moth has a wing span of about one inch and is grey, marked with brown or black.

Potato Tuberworm

The potato tuberworm was brought into the state in 1932 on a shipment of several thousand barrels of potatoes from Virginia. Most of this was seized and recovered before distribution. It did not appear to be a problem in 1933. In 1963, it was brought in again, apparently in stock shipped from out-of-state.

It became established and spread in Monroe County and northern Ohio potato fields. It was known to occur in a farm storage during the summer of 1968.

The main hosts are potato, tomato, tobacco (where it is known as the split worm), eggplant, and peppers. It is also found in other plants of the nightshade (potato and tobacco) family such as horsenettle, ground cherry, nightshade, jimson weed, henbane, matrimony vine and mullein.

The potato tuberworm is a small (up to 1/2 inch long), dark-headed and light-bodied (sometimes tinged with pink or green) caterpillar. These larvae are found in blisters on the leaves, in rolled leaf tips, in the stalks, and later in the season, in the tubers (especially in the green heads). The adult is a small grey moth with a wing expanse of about 1/2 inch. The moth flits nervously about potato plants in the field.

The adults start to lay eggs within two or three days after emerging from the pupal cases and continue for several nights. Eggs are laid singly on the leaves or other parts of the plant or tubers. Upon hatching, the small larvae bore between the surfaces of the leaves or into the stem (similar to European Corn Borer). The leaf damage is in the form of a leaf-roll or a watery blister (sometimes called a mine). As the potato vines mature and tubers develop, eggs are laid on exposed green heads, followed by infestation of tubers deeper in the soil. In storage, the moths and larvae continue to infest tubers if held at temperatures above 50° Farenheit.

It is doubtful the insect can withstand Michigan winters, however, potatoes stored at temperatures considered ideal for potato chip stock are also ideal for reproduction of the tuberworm. Infested stock in these type storages pose a potential threat to potato production in Michigan.

Vegetable Plant Quarantine

Living vegetable plants transported into Michigan serve as a source of introduction of plant pests and may cause great loss in crop production in the state. Plants of tomato, pepper, onion, cabbage, broccoli, cauliflower and sweet potato transported into the state must be free from soil, or in soil freed from plant pests by methods acceptable to the certifying agency, and are required to be accompanied by a certificate issued by the proper authority of the state of origin. The certificate establishes that the plants were grown and approved under an official plant pest control certification program of the state of origin or were inspected and certified to be free of plant pests on the basis of an inspection made not more than 3 days prior to shipment or transportation.

C. Other State Regulatory Controls

Michigan has other regulatory control programs to prevent the spread of dangerous insect pests and diseases. Seasonal programs for the detection of Cherry Fruit Fly and Peach Tree Viruses are conducted annually by the Michigan Department of Agriculture. These programs do not require pesticide applications on the part of regulatory personnel, but result in detected infestations being controlled or destroyed by the property owner.

It is also important to mention here that Michigan has legislation prohibiting the use of 2,4-D (2,4-Dichlorol phenoxyacetic acid), 2-4-5-T (2-4-5-Trichlorophenoxyacetic acid) or MCP (2 Methyl 4, chlorophenoxyacetic acid) in proximity to grape vineyards or crops of grapes. The use of these materials has caused serious damage and crop losses in the grape producing areas of the state.

CHAPTER I

Now that you have studied Chapter I, answer the following questions. Write the answers in pencil without referring back to the text. When you are satsified with your written answers, see if they are correct by checking them with the text.* Erase your answer and write in the correct answer if your first answer is wrong. Note that these questions are not necessarily those that are used in the certification examination.

1. In regard to the control of pest spread, what authority does the Secretary of Agriculture have?

2. Where can you find detailed information about regulated pests, life cycles and distribution?

3. Why are nematode problems often undetected?

4. How is the golden nematode of potatoes being controlled?

5. To what areas of the United States has the boll weevil spread?

6. Why is witchweed a serious pest? (What damage does it cause?)

7. What are the four basic components of the gypsy moth control program?

8. Why are screwworms harmful?

9. How are the United States and Mexico protecting the North American continent against future screwworm migrations?

10. What are the results of scabies infestation in cattle?

11. What disease do cattle fever ticks spread?

12. How are cattle fever ticks controlled?

13. What is the procedure for importing plants from a foreign country?

14. What type of damage does the geranium plume moth cause?

15. What are the main hosts of the potato tuberworm?

16. Explain in detail the restrictions placed on plants of tomato, pepper, onion, cabbage, broccoli, cauliflower and sweet potato in order to transport them into Michigan.

17. Name three pesticides that have caused serious damage and crop losses in the grape-producing areas of the state and are now prohibited from use in proximity to grape vineyards or crops of grapes.

*The questions are arranged in the order that they appear in the text.

CHAPTER II

FACTORS INFLUENCING PEST SPREAD

A. Pest Introduction

Prior to the enactment of quarantine legislation beginning in 1912, man regarded the introduction and spread of pests as unavoidable. During the late 1800's, a number of disastrous pest introductions into the U. S. dramatized the need for regulatory action. Many organisms which are of no serious consequence in their native habitat can become serious pests when introduced into new areas. Cultural or environmental conditions, the presence of disease, natural predators and parasites and other factors may keep an organism at levels where no significant damage is caused. However, when that organism is introduced into a new habitat, the natural controls are not present and it may become a pest. The possibilities of introduction of pests into new areas have been enhanced considerably as man has increased the speed and the frequency of his movement and the quantity of material being transported.

B. Pest Spread

In discussing pest spread, it is important to distinguish between natural spread and artificial spread. Natural spread is the movement the pest is capable of making without the interference of man. Artificial spread is the movement of a pest caused by man.

Pests are capable of movement within the environment. Natural spread may be either local or long distance, and caused by such factors as migration, seeking food and mate, host dispersal movement with soil, water and air current.

Prevention of artificial spread is one objective of pest regulatory programs. The potential for artificial spread has taken on new dimensions in recent years with the rapid modes of transportation which permit an organism to arrive in a new location in viable condition.

The introduction of an organism into a new area does not ensure its establishment. A number of factors may be involved in its becoming established:

- introduction must be into a favorable environment such as the availability of an appropriate host during a specific period; for example, fruit or seed infesting insects must be introduced when the host is producing fruit or seed;
- species requiring alternate hosts must arrive in a location where both hosts occur in the proper sequence; and
- the pest must be physiologically sound and the pest must arrive in numbers sufficient to allow for natural attrition from environmental factors and to permit reproduction.

If every entry of a pest established an infestation, regulations and quarantines on the movement of materials would be impractical because of the impossibility of interception of every infested lot of material. Regulatory programs attempt to reduce the movement of infested materials to such a low level, that the likelihood of establishment of the pest in new areas is minimal.

C. Population Dynamics

In order to evaluate the potential seriousness of a pest, it is necessary to have considerable information about the environmental requirements of the pest. Regulatory programs are generally concerned with entire populations of the pest species.

Major characteristics of pest populations important in designing regulatory programs include population densities, birth and death rates, age distributions, biotic potential and growth. Control or eradication programs must consider all life stages of the organism not just the stage which is the pest. It is necessary to know what effect such factors as pesticides, parasites, predators, host resistance have on all life stages of the pest organism. However effective a factor may be against a given stage of a pest, its long term value is limited if it does not account for significant decreases between generations. For example, even if a high percentage of the larval stage of a pest is killed by control techniques, the remaining population may have the reproductive potential for significant damage by the next generation of the pest.

Studies of life cycles can often identify critical life stages and other factors which are important in producing population changes. Recognition of these key factors and their influence on pest population may permit development of controls which have significant impacts in reducing the populations.

These factors, which normally have an important limiting effect on native pest populations, may include resistance of host material to the pest, the presence of parasites or climatic conditions. The absence of these factors is often responsible for the explosion of a pest population when it is introduced into a new environment.

CHAPTER II

Now that you have studied Chapter II, answer the following questions. Write the answers with pencil without referring back to the text. When you are satisfied with your written answers, see if they are correct by checking them with the text.* Erase your answer and write in the correct answer if your first answer is wrong. Note that these questions are not necessarily those that are used in the certification examination.

1. How does natural spread differ from artificial spread?

2. List three factors involved in the establishment of an organism in a new area.

3. Why must pest lifecycles be studied?

4. List three factors that normally have an important limiting effect on native pest populations.

*The questions are arranged in the order that they appear in the text.

CHAPTER III

METHODS OF CONTROL

The success of most regulatory programs depends upon many diverse but related factors, among which is adequate pest control. Satisfactory control of a pest population must be maintained at the point of origin so that the possibility of long distance spread is greatly reduced. Once an introduction occurs, the need for chemical control becomes essential. The implementation of chemical controls when pest populations are newly established and not widely distributed is both economically sound and biologically feasible.

The selection of the proper method of control and the suitable pesticide is based upon many different considerations. A few are listed below:

1. Pest species, lifecycle, method of dispersal and mode of attack.
2. Host species and location of infestation.
3. Method of pesticide application: mist blower, hand seed caster, fumigation, soil injection or aircraft, animal dip vats, spray dip machine.
4. Formulation of pesticide: bait, dust, wettable powder, granular, aerosol, emulsifiable concentrate, or gas.
5. Mode of pesticide action: contact, fumigant, stomach poison or soil sterilant.
6. Size and location of areas selected for treatment.
7. Effect of pesticide on target and non-target organisms.

As in the section on regulated pests, anyone wishing detailed information about a particular regulated species, the recommended pesticides, methods of pesticide application, and the necessary precautions, is referred to manuals

prepared for personnel of the Animal and Plant Health Inspection Service (APHIS), in USDA, APHIS, area offices or in the regulatory offices of cooperating states.

CHAPTER III

Now that you have studied Chapter III, answer the following questions. Write the answers in pencil without referring back to the text. When you are satisfied with your written answers, see if they are correct by checking them with the text.* Erase your answer and write in the correct answer if your first answer is wrong. Note that these questions are not necessarily those that are used in the certification examination.

1. Is the implementation of chemical controls a good practice when pest populations are newly established and not widely distributed?

2. List at least seven possible methods of pesticide application.

3. List at least four possible modes of pesticide action.

4. Where can you find detailed information about a particular regulated species, the recommended pesticide, methods of pesticide application and the necessary precautions?

*The questions are arranged in the order that they appear in the text.

CHAPTER IV

PRINCIPLES OF CONTROL

The strategies for plant and animal pest control depend upon the successful blending of many skills. Rarely does any one single method prove successful for a sustained period of time unless supporting measures are soundly conceived. There are four basic strategies for protecting plants from pests:

1. Prevention of entry.
2. Eradication of infestation.
3. Retardation of spread.
4. Mitigation of losses.

These strategies are evolutionary in concept and in practice one is gradually replaced by the next.

Prevention of Entry

Quarantine programs at ports of entry are directed at the prevention of pest introduction; consequently, all incoming commodities are inspected, all infested host material is treated or destroyed, and certain hazardous agricultural products are prohibited from entry.

Eradication

Once an introduction occurs and where effective tools are available, the immediate objective of the program is complete eradication of the pest species. Generally, all means available including applications of pesticides are made to achieve this objective.

Retardation of Spread and Mitigation of Losses

In other cases, where the pest has become firmly established and eradication is not feasible, the objectives are different, depending on the pest populations, damages being experienced and likelihood of long distance spread. Quarantines, inspection and chemical treatment or other appropriate measures are used to reduce the possibility of long distance spread. In other areas where pest populations are high and damage is occurring, an integration of control measures may be used. Among these measures are: release of parasites and predators, release of sterile males, removal of host, use of pesticides, resistant varieties.

CHAPTER IV

Now that you have studied Chapter IV, answer the following questions. Write the answers in pencil without referring back to the text. When you are satisfied with your written answers, see if they are correct by checking them with the text.* Erase your answer and write in the correct answer if your first answer is wrong. Note that these questions are not necessarily those that are used in the certification examination.

1. List in order the basic strategies for protecting plants from pests.

2. Explain what happens in quarantine programs at ports of entry.

3. What means are used to eradicate a pest species?

4. List at least four control measures that might be used in an integrated control program.

*The questions are arranged in the order that they appear in the text.

CHAPTER V

USING PESTICIDES SAFELY IN REGULATORY PROGRAMS

Regulatory personnel have three basic responsibilities when conducting pest control programs. Foremost is their responsibility to the public; secondly, to control the regulated pest; and thirdly, to protect non-target species.

Pest control programs conducted by regulatory personnel most always come under public scrutiny, and care must be exercised to insure good public relations and safe use of pesticides. Personnel should be courteous to the public at all times and be able to provide answers to interested and concerned citizens. They need to understand the scope of the pest problem being controlled and the method of application, the relative hazard of the pesticide being used, its effect on non-target species, and any hazard to the environment. Consideration should always be given to the best methods to control the regulated pests with a pesticide while minimizing its effect on non-target species.

It should be made clear that environmental effects from pesticides are not necessarily deleterious. There are numerous examples where environmental benefits have been gained by the careful selection and judicious use of pesticides. In other situations, the use of pesticides can result in neutral or indeterminate impacts on the environment.

Ideally, the pesticide used should be one that is as effective as possible against one or more target pests and as safe as possible to all other forms of life. When selecting a pesticide consideration should be given to the following:

1. A pesticide which is as selective as possible and has the least impact on non-target species.

2. A pesticide and a formulation which can be used at the lowest amount per unit area.
3. A pesticide which will control the pest during a desired period of time. Additional persistence beyond that time is unnecessary and unwanted.
4. A pesticide which can be easily applied to the desired target without drift and drainage problems. Use of spray adjuvants and coarse droplets are helpful in reducing these problems.

The effectiveness of any pest control program depends greatly upon proper planning and sound management of the pesticide application. All treatment areas must be kept as small as possible and all sensitive areas (water, pasture land, residential areas, etc.) must be carefully noted. Consideration must always be given to areas adjacent to treatment sites. Continuous monitoring of weather conditions (wind, humidity, precipitation, etc.) should be performed prior to and during application. Care must be taken to avoid run-off of any pesticide, and where possible, all animals and birds should be excluded from the treated area. All standing bodies of water should be avoided and caution should be taken when work is conducted near such areas.

Avoiding Harmful Residues in or on Food and Feed

Residues in excess of the established legal tolerances can be avoided by applying only those pesticides specified for use on the crop or livestock and by following indicated schedules. Do not exceed recommended dosages. Observe carefully the safety restrictions, especially the required interval between the last application and harvest or feeding, and between the last application and slaughter of animals.

Avoid drift of pesticide sprays or dust to nearby crops or livestock, especially from applications by aircraft and other power equipment. Do not allow poultry, dairy animals, or meat animals to feed on plants or drink water contaminated by drift of pesticides.

In storage areas, apply only those pesticides registered for the purpose. A commodity that comes in contact with floors or walls treated with pesticides not registered for use in storage areas may become contaminated. Repeated applications of some fumigants will cause residues to build up in the commodities.

In selection of a pesticide for treatment of a commodity, consideration must be given to tolerance of commodities.

The tolerance of a commodity treatment may be concerned with either chemical or physical causes with possible modifications of taste, ordor, appearance, ripening rate, viability or vitality. Another factor to be considered when applying pesticides is the potential toxicity to plants and animals. Species vary in their tolerance to different pesticides. The condition of the plant material at the time of treatment may have a decided bearing on its reaction to treatment.

Wildlife - Water

The use of pesticides can potentially affect non-target fish and wildlife resources. The consequences of pesticide exposure to wildlife may be severe, subtle or nonexistent, depending upon many factors. The size and scope of regulatory pest control programs vary from single pesticide treatments of balled and burlapped trees to multiple aerial applications to several thousand acres of land.

Pesticides may enter surface waters as a result of intentional application, drift, drainage, dumping, disposal of waste water after the cleaning of contaminated equipment, wind-blown treated materials, accidental spills and improper disposal of pesticide containers. Once in the aquatic environment, the pesticides may affect aquatic organisms directly or indirectly. An example of direct effect would be a fish kill. Contamination of aquatic food organisms would be an example of an indirect effect.

Contamination by pesticides may occur from aerial drift during pesticide applications, discharges during and after fumigation, vaporization, burning of pesticides and containers and wind erosion. At times, these materials may be carried considerable distances.

Terrestrial animals may be affected directly or indirectly by pesticides. As with aquatic organisms, the contamination may occur as the result of intentional application, dumping or accidental spills.

Bees

Honeybees and other beneficial insects can be affected by some pesticide applications. To reduce these possible effects on honeybees a close coordination and cooperation must be established and maintained between regulatory pest control personnel and members of the beekeeping industry. While it is not always possible to completely prevent all bee losses, it is possible to reduce significantly losses through careful planning and good communications. Hives within one mile of an area treated with a pesticide toxic to bees should be considered as being exposed to potentially hazardous pesticide doses. Listed below are factors to consider in an effort to reduce field losses of honeybees and other beneficial insects:

1. The kind and amount of pesticide used is important. Use the proper dosage of the safest material (to bees) that will give good pest control.

2. When using materials hazardous to bees, notify the beekeeper so that he may protect his bees.
3. With few exceptions, dusts are more hazardous to bees than sprays.
4. Airplane applications are more hazardous to bees than ground equipment applications.
5. Treating large areas and repeating applications may cause greater bee losses.
6. Time of application is important and depends on blooming period and attractiveness of crop. Treatments when bees are foraging in the field are usually the most hazardous. Treatments over colonies in hot weather when bees are clustering on the outside may cause severe losses. Treatments during the night and early morning before bees are foraging are the safest.
7. Treating a nonblooming crop with a hazardous material when cover crops, weeds, or wild flowers are in bloom in the field or close by may cause heavy bee losses. Drift of pesticides to neighboring fields attractive to bees also may cause losses.

CHAPTER V

Now that you have studied Chapter V, answer the following questions. Write the answers in pencil without referring back to the text. When you are satisfied with your written answers, see if they are correct by checking them with the text.* Erase your answer and write in the correct answer if your first answer is wrong. Note that these questions are not necessarily those that are used in the certification examination.

1. What are the three basic responsibilities of regulatory personnel?

2. List four desirable characteristics for a safe and effective pesticide.

3. How can you prevent residues in excess of the established legal tolerances?

4. What factors may be involved in the tolerance of a commodity treatment?

5. By what means can pesticide contamination of water occur? (List as many as you can think of.)

6. List at least five ways to minimize pesticide danger to honeybees.

*The questions are arranged in the order that they appear in the text.

CHAPTER VI

EMERGENCY PROCEDURES

Although it is a violation of Federal law to use a pesticide in a manner inconsistent with its labeling, there are special emergency situations which arise in pest programs. For example, when a new pest is introduced into the country, there is not likely to be a pesticide registered with which to combat the new introduction since the pest will not be specifically mentioned in the directions for use on the pesticide label. Section 18 of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), as amended, provides authority for the Administrator of EPA to exempt any Federal or State agency from any provision of FIFRA if he determines that an emergency condition exists requiring such exemption. There are three types of exemptions as defined by EPA regulations:

1. Specific Exemption - May be issued for situations involving outbreaks of pests and must be requested in writing by the head of the Federal agency or the Governor of the State involved or his designee.
2. Quarantine - Public Health Exemption - May be issued for Federal or State programs concerned with preventing the introduction or spread of a foreign pest into or throughout the United States. As with specific exemptions, these exemptions must be requested in writing by the head of the Federal agency or the Governor of the State or his designee. The term "foreign pest" is defined to include any pest not known to occur or not previously known to be established in the United States but which has become or threatens to become established.

3. Crisis Exemption - Whenever any Federal or State agency determines that there is a situation involving the unpredictable outbreak of a pest and a responsible official in authority determines that there is a bona fide emergency as defined, a crisis exemption may be invoked if the need is so critical as to preclude application for a specific exemption. Such exemptions may not involve the use of any pesticide which has been suspended or finally cancelled for the use in question.

In situations of a highly localized nature in states which have such capabilities, consideration may be given to obtaining registration for "special local needs" through the state pesticide regulatory agency. Complete regulations and guidelines for registration are available from EPA.

In order to facilitate label registration for regulated pests, it is possible to have the USDA, APHIS, treatment manuals considered a part of the pesticide product labeling through the addition to the label of a statement similar to the following:

"Also for use in accordance with the recommendations and instructions issued by the United States Department of Agriculture for quarantine programs. To be used only by or under the direction of Federal/State personnel for quarantine treatments."

Such an addition to a pesticide label will enable usage in quarantine programs simply by EPA acceptance of changes in the treatment manuals and such uses will not be considered inconsistent with the labeling.

CHAPTER VI

Now that you have studied Chapter VI, answer the following questions. Write the answers with pencil without referring back to the text. When you are satsified with your written answers, see if they are correct by checking them with the text.* Erase your answer and write in the correct answer if your first answer is wrong. Note that these questions are not necessarily those that are used in the certification examination.

1. Who has the authority to exempt a federal or state agency from a provision of FIFRA (Federal Insecticide, Fungicide and Rodenticide Act)?

2. In what situation may a specific exemption be issued?

3. In what situation may a quarantine public health exemption be issued?

4. Can a crisis exemption involve the use of a pesticide that has been cancelled for the use in question?

5. What must be done to enable APHIS (Animal and Plant Health Inspection Service) treatment manuals to be considered a part of the pesticide product labeling?

*The questions are arranged in the order that they appear in the text.

CHAPTER VII

SPECIAL EQUIPMENT

Specialized equipment is sometimes used in plant and animal pest control. The type of equipment will vary depending upon the pest to be controlled, pesticide used and the application site. Regulatory personnel should be familiar with the application equipment they are using plus any equipment that may be used to monitor the pesticide application. The following are examples of special equipment used in pest control programs:

1. Refrigerated machines to transport and distribute sterile insects are presently being used to drop Pink Bollworm moths. This technique has also been tested for effectiveness in eradication or control programs.
2. Machines to inject soil fumigants are used to control plant nematodes.
3. Fumigation chambers are used to destroy insect pests intercepted at points of entry and on occasions when an insect pest may have escaped detection at the point of entry.
4. Fumigation accessory equipment is available to make determination of fumigant concentration in the field. The equipment is used to make determinations at regular intervals of fumigant concentration in the enclosure, to detect leaks from the enclosure and the injection system during fumigant introduction and during the fumigation process and to measure the presence or absence of residual fumigant during the aeration process. More information about special equipment may be obtained from APHIS manuals, the FAO Manual of Fumigation for Insect Control or the manufacturer.

5. Vat dipping is the only officially recognized method of treating sheep and goats for ticks and scabies and is the preferred method for treating cattle, horses and most other species of animals. Cattle and swine may also be treated using a spray-dip machine. Engine-driven tank-type spray equipment with constant mechanical mixing of the bath is not an acceptable method of treatment except under certain circumstances for treating easily restrained horses and, when specifically authorized, certain zoo or domestic animals. Hand-powered sprayings are not acceptable.

The above are only a few examples of specialized equipment available for use in regulatory pest control. The important thing to remember is to select the proper equipment, become familiar with its operation, and operate the equipment in the correct manner.

CHAPTER VII

Now that you have studied Chapter VII, answer the following questions. Write the answers with pencil without referring back to the test. When you are satisfied with your written answers, see if they are correct by checking them with the text.* Erase your answer and write in the correct answer if your first answer is wrong. Note that these questions are not necessarily those that are used in the certification examintaion.

1. What determines the type of equipment to be used in plant and animal pest control?

2. When are fumigation chambers used?

3. List three important uses of fumigation accessory equipment.

4. Where can you find information about special equipment?

5. Are hand-powered sprayings acceptable for treating domestic animals?

*The questions are arranged in the order that they appear in the text.